REMARKS

Claims 2-3 have been cancelled and claims 1, 31, and 32 have been amended. Claims 1, 4-18 and 29-32 are pending. The claims have been amended to describe an apparatus for processing a workpiece, including an ozone gas supply for providing ozone gas around the workpiece, and a sonic energy source for introducing sonic energy through a layer of liquid on the workpiece. Reconsideration and withdrawal of the rejections are requested.

Turning to the § 103 rejections at paragraphs 3-5 of the Office Action, claim 1 has been amended to describe introducing sonic energy to the workpiece through the layer of liquid on the workpiece. The principal reference JP '927 describes a purely dry ozone ashing process. In JP '927, the wafer is heated to 120° in an ozone environment. After a certain weight percentage of ozone is consumed, the wafer is sprayed with hot sulfuric acid (translation, page 5, para. 55). Accordingly, there is no wet processing at all in JP'927. The ozone in JP '927 is used only when the wafer is hot (120°C) and dry. As noted at paragraph 3 of the 5/5/2004 Office Action, JP'927 does not suggest use of sonic energy.

The secondary references Miki, Kanno and JP '714 are each cited for disclosing use of sonic energy. However, each of these secondary references describes a wet process. Since dry ozone ashing processes as in JP '927 are entirely inconsistent with wet processes, the combination of JP'927 with any of the secondary references is improper. Indeed, JP '927 teaches away from having a layer of liquid on the wafer, as now described in amended claim 1, because the wafer temperature is far above boiling temperatures, and because JP '927 uses a direct ozone gas to wafer surface

interaction. Moreover, JP '927 teaches away from the combined simultaneous use of both ozone and sonics, because there is no medium in a dry ozone ashing process for transmitting sonic energy to the workpiece (since the sonic energy cannot be effectively transmitted to the wafer through a gas—an incompressible medium such as a liquid or solid is needed). Claim 1 accordingly is allowable.

Kanno et al teaches that an ultrasonic wave generator 63 is placed at a lower region or a side of a cleaning tank 62 (see col. 8, lines 11-13 and 39-41; Figs. 7, 9-11). In operation, a wafer 60 is immersed in a cleaning fluid in the cleaning tank 62 (see col. 8, lines 37-39). Ultrasonic waves are then generated by the ultrasonic wave generator 63 to impart vibrational energy into the cleaning liquid (see col. 8, lines 39-41). Such an immersion technique, in which a wave generator produces ultrasonic waves into a cleaning liquid, is well known in the art. Amended claim 1, on the other hand, includes a sonic energy source for introducing sonic energy to the workpiece through a liquid layer on the workpiece. This element is not taught or suggested in Kanno, as immersion systems do not form a liquid layer.

JP '714 discloses that ultrasonic vibrators 3a-3d on outer surfaces of substrate holding parts 2a, 2b (see Fig. 2). The ultrasonic vibrators 3a-3d are apparently in solid contact with the substrate 1 via the substrate holding parts 2a, 2b. JP '714 teaches that it is not desirable for the substrate holding parts 2a, 2b to attenuate vibrational energy, (see translation, paragraph 0013). There is no transmission of sonics through a liquid layer, as JP '714 apparently uses a direct mechanical connection from the vibrators through the holding parts to the substrate.

Miki discloses that a first ultrasonic wave oscillator 604 is located inside a front surface nozzle 602, and/or a second ultrasonic wave oscillator 605 is located inside a rear surface nozzle 603 (see col. 14, lines 7-12; Figs. 6a and 6b). It is not clear how sonic energy is transmitted from the nozzles to the wafer, since the drawings show the nozzles spaced apart from the substrate. Col. 24, lines 20-25 describe superposing high frequency sound waves on the substrate via the cleaning liquid, although the mechanism for doing so is not described. Miki at Col. 21, line 31 also suggests use of a sealed chamber at a reduced pressure of 100 Torr. This teaches away from an ozone gas supply system that provides ozone gas around the workpiece, as claimed, since reduced pressure corresponds to reduced presence of gas in the chamber. Miki also does not suggest use of a heater.

Accordingly, even if the references are combined and applied as in paragraph 3 of the 5/5/04 Office Action, claim 1 remains patentable.

Claims 31 and 32 now describe a sonic energy source direct or physical contact with the workpiece, features not shown in the prior art. In JP '714, the vibrators are located on outer surfaces of the substrate holding parts 2a, 2b (See Fig. 2). Consequently, they are not in direct or physical contact with the workpiece as claimed.

[Continued on next page.]

In view of the foregoing, it is submitted that the claims are in condition for allowance, and a Notice of Allowance is requested.

Dated: July 7, 2004

Respectfully submitted,

PERKINS COIE LLP

Customer No. 34055
Perkins Coie LLP
Patent - LA
P.O. Box 1208
Seattle, WA 98111-1208
Phone: (310) 788-9900
Fax: (310) 788-3399

By: Kenneth H. Ohriner
Kenneth H. Ohriner
Reg. No. 31,646

COMPLETE SET OF CLAIMS:

1. (Currently Amended) An apparatus for processing a workpiece comprising:

a liquid supply source;

one or more liquid outlets disposed to apply a layer of liquid onto the workpiece;

a liquid flow line extending between the liquid supply source and the one or more liquid outlets for carrying liquid to the liquid outlets;

at least one heater for heating the liquid before it is applied onto the workpiece;

an ozone gas supply system which provides ozone gas around the workpiece while the layer of heated liquid is on the workpiece; and

a sonic energy source for introducing sonic energy to the workpiece through the layer of liquid on the workpiece.

2-3. (Cancelled).

4. (Previously presented) The apparatus of claim 1 wherein the sonic energy source is associated with the liquid outlets, to provide sonic energy to the workpiece via liquid moving out of the outlets and onto the workpiece.

5. (Original) The apparatus of claim 1 wherein the sonic energy source comprises a sonic transducer including a focusing chamber for concentrating sonic energy onto the workpiece.

6. (Original) The apparatus of claim 1 where the liquid supply source comprises a liquid reservoir, and where the heater heats the liquid in the reservoir.

7. (Original) The apparatus of claim 1 where the liquid supply source includes a liquid selected from the group consisting of, ammonium hydroxide, sulfuric acid, hydrochloric acid, hydrofluoric acid, a surfactant, de-ionized water, and a combination thereof.

8. (Original) The apparatus of claim 1 further comprising a chamber around the workpiece and with the ozone gas supply connected to the chamber to provide ozone gas around the workpiece in the chamber, with the ozone provided as a dry gas or in a liquid.

9. (Original) The apparatus of claim 8 further comprising a re-circulation liquid line extending between the chamber and the liquid supply source.

10. (Original) The apparatus of claim 8 further comprising a rotor assembly in the chamber for rotating the workpiece.

11. (Original) The apparatus of claim 1 where the liquid outlets comprise liquid nozzles for spraying the heated liquid onto the workpiece.

12. (Original) The apparatus of claim 1 further including means for controlling the thickness of a layer of the liquid formed on the surface of the workpiece.

13. (Original) The apparatus of claim 12 where the means for controlling comprises a liquid flow control system for controlling the flow of liquid onto the workpiece.

14. (Original) The apparatus of claim 13 where the liquid flow control system includes spray nozzles.

15. (Original) The apparatus of claim 12 where the means for controlling comprises a rotor for holding and rotating the workpiece.

16. (Original)) An apparatus for treating the surface of a workpiece comprising:

a liquid reservoir for holding a process liquid;

a process chamber;

a workpiece holder within the process chamber;

liquid spray nozzles within the process chamber disposed to spray liquid onto the workpiece held by the workpiece holder;

a liquid flow line extending between the liquid reservoir and the liquid spray nozzles;

an ozone generator for generating a supply of ozone;

one or more ozone supply lines extending from the ozone generator to the process chamber;

at least one heater for heating the process liquid; and

a sonic energy source on the workpiece holder for introducing sonic energy to the workpiece.

17. (Previously Presented) The apparatus of claim 16 where the workpiece support holds the workpiece in a horizontal orientation.

18. (Previously Presented) The apparatus of claim 16 further comprising a valve connecting to a spent liquid line extending from the process chamber, to the liquid reservoir, and to a drain, with the valve switchable between a first position, wherein spent liquid from the process chamber is directed back to the reservoir, and a second position, wherein spent liquid from the process chamber is directed to the drain.

19 – 28. (Cancelled)

29. (Previously Presented) An apparatus for processing a workpiece comprising:

a process chamber;

a workpiece holder within the process chamber for holding a workpiece;

a liquid source for delivering a liquid to a surface of the workpiece to form a liquid layer on the workpiece surface;

an ozone supply system for delivering ozone into the process chamber; and

a sonic energy source on a swing arm for delivering sonic energy through the liquid layer to the workpiece surface, with the swing arm moveable to deliver the sonic energy to the workpiece.

30. (Previously Presented) The apparatus of claim 29 wherein the sonic energy source is associated with the liquid source for delivering sonic energy to the workpiece via the liquid delivered from the liquid source.

31. (Currently Amended) An apparatus for cleaning a workpiece, comprising:

a process chamber;

a workpiece holder within the process chamber;

an ozone supply system for delivering ozone into the process chamber; and

a sonic energy source on the workpiece holder for introducing sonic energy directly to a workpiece held on the workpiece holder; and

a liquid supply source for delivering a liquid on to the workpiece.

32. (Currently Amended) An apparatus for treating the surface of a workpiece comprising:

a process chamber;

a workpiece holder within the process chamber for holding a workpiece;

a liquid supply source for delivering a liquid to a surface of the workpiece to form a liquid layer on the workpiece surface;

means for controlling a thickness of the liquid layer formed on the workpiece surface;

an ozone supply system for delivering ozone into the process chamber; and

a sonic energy source in ~~mechanical or fluid~~ mechanical contact with the liquid layer on the workpiece surface for delivering sonic energy through the liquid layer to the workpiece surface.